



28 MAY 2003

Aerospace Medicine

CONTROL OF HEAT STRESS

COMPLIANCE WITH THIS PUBLICATION IS MANDATORY

NOTICE: This publication is available digitally on the AFDPO WWW site at:
<http://www.e-publishing.af.mil>

OPR: 6 AMDS/SGPB (SSgt Borth)
Supersedes MACDI 48-102, 2 October 1996

Certified by: 6 MDG/CC (Col Newton)
Pages: 9
Distribution: F

This instruction assigns responsibilities and gives guidance on preventing heat stress. It applies to all industrial organizations and tenant units on MacDill Air Force Base.

SUMMARY OF REVISIONS.

This revision reflects changes to work rest cycles outlined by the Air Force Medical Operations Agency (AFMOA) and adds examples of the different workload categories. Additionally, it reflects changes in Wet Bulb Globe Temperature (WBGT) monitoring times and notification procedures; adds **Table 1**. A bar (|) indicates new or revised material since the last edition.

1. References. AFPAM 48-145 *Thermal Injury*; Fundamentals of Industrial Hygiene, Chapter 12 (Temperature Extremes); American Conference of Governmental Industrial Hygienists, Threshold Limit Values for Physical Agents in the Work Environment; and Revised Policy on the Role of Sports Drinks in the Prevention of Dehydration and Heat Illness.

2. Terms Explained.

2.1. Acclimatization. Acclimatization is a series of physiological adjustments that occur when an individual is exposed to a hot climate. A period of approximately 2 weeks with progressive degrees of heat exposure and physical exertion should be allowed for substantial acclimatization (about 78 percent). Acclimatization to heat begins with the first exposure and is usually developed to about 45-52 percent by the end of the first week. Full acclimatization is attained most quickly by gradually increasing work in the heat. Full heat acclimatization can be achieved by as little as two 50-minute periods of work in the heat each day. Once acclimatized, personnel will retain most of the adaptation for about 1 week after leaving a hot climate.

2.2. Heat Disorders. Heat disorder is a general term used to indicate any type of adverse heat related health problems. Heat cramps, exhaustion, and stroke are all forms of heat disorder. Heat disorders may be recognized by one or more of the following symptoms: nausea, vomiting, fever, dizziness,

headache, faintness, abnormal sweating, convulsions, lack of coordination, mental confusion, unconsciousness, and abdominal or leg cramps. Personnel most likely to be affected by the heat are those individuals who have just arrived from cooler regions of the country, are obese, or are in poor condition. Heat disorders are as follows:

2.2.1. Heat Cramps. Heat cramps are painful intermittent spasms of the voluntary muscles. Cramps may result from exposure to high temperature for a relatively long time, particularly if accompanied by hard physical work. Cramps usually occur after heavy sweating and are the result of excessive loss of salt from the body. Even if the moisture is replaced by drinking plenty of water, the loss of salt by sweating may cause heat cramps.

2.2.2. Heat Exhaustion. The signs of heat exhaustion are profuse sweating, weakness, rapid pulse, dizziness, nausea, and headache. With heat exhaustion, the skin is cold and sometimes pale and clammy with sweat, and body temperature is normal or below normal. Nausea, vomiting, and unconsciousness may also occur.

2.2.3. Heat Stroke. Heat stroke is caused by exposure to a hot environment in which the body is unable to cool itself sufficiently. This results in the body temperature rising rapidly. Heat stroke is a much more serious condition than heat cramps or heat exhaustion. The skin is usually hot, dry, and flushed. Increased body temperature, if uncontrolled, may lead to delirium, convulsions, coma, and even death. Heat stroke is a medical emergency.

2.3. Heat Stress. Heat stress is the combination of environmental and physical work factors that constitute the total heat load imposed on the body. The environmental factors of heat stress are the air temperature, radiant heat exchange, air movement, and water vapor pressure. Physical work contributes to the total heat stress of the job by producing metabolic heat in the body in proportion to the intensity of the work.

2.4. WBGT Index. The WBGT index is the most practical heat stress index for characterizing the effect of a heat stress environment on an individual because it takes into account humidity, wind speed, and radiant load. WBGT values are calculated by the following equations. All readings are given in degrees Fahrenheit:

2.4.1. Outdoors with solar load: $WBGT = 0.7 WB + 0.2 BG + 0.1 DB$.

2.4.2. Indoors or outdoors with no solar load: $WBGT = 0.7 WB + 0.3 BG$.

2.4.3. Legend: WB = Wet Bulb; BG = Black Globe; and DB = Dry Bulb.

NOTE: The wet bulb temperature is always below the dry bulb temperature except when the relative humidity is 100 percent. At this point, both temperatures are equal.

2.5. Workload. The physical demands of duties being performed. For the purpose of heat stress, workload is divided up into three categories. Examples of each category are given below:

2.5.1. Light Work: Drill and ceremony, gate duty.

2.5.2. Medium Work: Mechanical work performed outdoors, carrying weapon while patrolling.

2.5.3. Heavy Work: Hand digging, assembly/disassembly of satellite communications equipment, aircraft washing.

2.6. Caution: WBGT range from 77.0 to 86.9. While in this category, outdoor physical training should be limited for un-acclimatized personnel. Adjust work/rest cycles and increase water consumption according to table.

2.7. Extreme Caution: WBGT range from 87.0 to 89.9. While in this category, outdoor physical training should be limited for all un-acclimatized personnel. Adjust work/rest cycles and increase water consumption according to table.

2.8. Danger: WBGT of greater than 90.0. While in this category, outdoor physical training should be limited for all personnel. Adjust work/rest cycles and increase water consumption according to table.

3. Responsibilities.

3.1. Commanders/Supervisors:

3.1.1. Make sure personnel take heat stress preventive measures during the summer months and especially when the WBGT index reaches 90 degrees Fahrenheit. Ensure that first line supervisors brief all personnel on a routine basis and prior to all exercises on heat stress prevention using the guidance in [Attachment 2](#). Add heat stress hazards/training to workers on AF Form 55, **Employee Safety and Health Record**.

3.1.2. During the hot season, schedule physical conditioning and strenuous activities early in the day or late in the afternoon.

3.1.3. Emergency Treatment. In the event an individual suffers a heat disorder, take the following steps:

3.1.3.1. Move the individual to a cooler (not cold) location or into the shade.

3.1.3.2. If the victim is conscious and not vomiting, give water to drink.

3.1.3.3. Drench with cool water and fan for additional cooling. Caution: Do not overcool; may cause hypothermia.

3.1.3.4. If the victim does not respond to the above, immediately call an ambulance (911). Give your name and location of the victim (building number and street). If an ambulance is not available, take the victim to the MacDill Hospital Emergency Room.

3.2. Wing Command Post: Advises base organizations of the onset and conclusion of heat stress conditions.

3.3. Public Health (PH):

3.3.1. Contacts Bioenvironmental Engineering on any patient with heat stress injuries found during normal surveillance for investigation and recommendations.

3.3.2. Provides guidance and training on controlling heat stress during normal job-related functions at the request of the supervisor. The heat stress briefing ([Attachment 2](#)) is provided for first line supervisors to brief their personnel routinely and prior to all exercises.

3.3.3. Upon the request of the commander, PH will provide a heat stress briefing to personnel who have the potential (occupational, recreational, deployment, etc.) of exposure to high temperature environments.

3.4. Bioenvironmental Engineering:

3.4.1. Investigates the impact of heat stress on industrial workers required to wear personal protective equipment.

3.4.2. Monitors the WBGT hourly based on local climate conditions, 1 May through 1 October, from 0800 hours until 1600 hours local time, Monday through Friday, unless inclement weather prevails. Additional monitoring may be accomplished before 1 May or after 1 October, as necessitated by heat stress conditions.

3.4.3. Makes notifications of the onset and conclusion of heat stress conditions and reports findings to the Wing Command Post (8-4361).

3.4.4. Investigates heat stress injuries through completion of AF Form 190, **Occupational Illness/Injury Report**, and makes recommendations to the appropriate commander/supervisor on further prevention of the heat stress injuries in their unit.

3.4.5. Advises commanders/supervisors on heat stress preventive control measures.

3.4.6. Notifies Base Weather Station (6th Operations Support Squadron, Weather Flight (6 OSS/OSW, 8-2854/4405) duty forecaster of current active heat stress category at the conclusion of Bioenvironmental Engineering's daily monitoring period.

3.4.7. Provides 6 OSS/OSW with equipment and annual training to enable them to augment WBGT monitoring.

3.4.8. Maintains equipment provided to Base Weather Station.

3.5. 6th Services Squadron: Fitness Center will provide notice to all patrons of current heat stress category.

3.6. Base Weather Station:

3.6.1. Monitors the WBGT hourly on weekends based on recommendation of Bioenvironmental Engineering (1 May through 1 October), unless inclement weather prevails. Additional monitoring may be accomplished before 1 May or after 1 October, as necessitated by heat stress conditions.

3.6.2. Monitors the WBGT weekdays after 1600 hours local until the conclusion of active heat stress conditions.

3.6.3. Makes notifications of the onset and conclusion of heat stress conditions and reports findings to the Wing Command Post (8-4361) except during the times Bioenvironmental Engineering performs monitoring, normally 0800 to 1600 Monday through Friday.

4. Factors Affecting Heat Stress or Increasing Potential for Heat Stress.

4.1. Unit Factors:

4.1.1. Fatalistic Attitude - "Some casualties are expected".

4.1.2. Poor Doctrine - That withholding water can make a "hot weather fighter".

4.1.3. Disregard for Weather - Meteorological conditions must be considered in establishing work/training goals for any given day.

4.1.4. No water or poor water supply at work and rest sites.

4.2. Individual Factors:

- 4.2.1. Any illness including reactions to immunizations.
- 4.2.2. An adequate acclimatization (2 hours/day of sweat work for 7 to 10 days are necessary). The process means you sweat more profusely and conserve more salt in your kidneys.
- 4.2.3. Are over 40.
- 4.2.4. Obesity.
- 4.2.5. Alcohol consumption, even the day before, dehydrates the body.
- 4.2.6. Lack of sleep/rest.
- 4.2.7. Lack of meals.
- 4.2.8. Poor weather discipline.

5. Preventive Measures. The following preventive measures are a guide to preventing heat stress. These measures provide some information for commanders and should not be construed as directive.

5.1. Prior to Exercise/Deployment/Work:

- 5.1.1. Condition for acclimatization - Need at least 2 hours each day for 7 to 10 days.
- 5.1.2. Accomplish all immunizations at least 7 days prior to exercise.
- 5.1.3. Screen out individuals with even minor illness, particularly any vomiting or diarrhea in the past 2-3 days, and pregnant women.
- 5.1.4. Be rested - 12 hours rest/8 hours of sleep.
- 5.1.5. No alcohol 24 hours prior to working in hot climate.
- 5.1.6. Prehydrate before work - drink at least 1 quart of water.
- 5.1.7. Brief personnel on [Attachment 2](#).

5.2. During Exercise/Deployment/Work:

- 5.2.1. After air transport, replace water loss in flight - 1 quart for every 4 hours in flight.
- 5.2.2. Provide sufficient water cooled to at least 60 degrees Fahrenheit.
- 5.2.3. Bioenvironmental Engineering can provide you with current WBGT readings. During deployments, the independent duty medical technician or equivalent should perform the WBGT readings, using the WBGT kit, NSN 6665-00-159-2218.

5.3. Control hydration and work/rest schedules according to the following chart:

Table 1. Work/Rest Guidelines.

WORK/REST GUIDELINES IN INDUSTRIAL ENVIRONMENTS							
Heat Category	WBGT Temperature Range	Easy Work		Moderate Work		Hard Work	
		Work/Rest	Water Intake	Work/Rest	Water Intake	Work/Rest	Water Intake
		Cycle	Qt/hr	Cycle	Qt/hr	Cycle	Qt/hr
Caution	77.0 - 86.9	No Limit	0.5	45/15 min	0.75	40/20 min	0.75
Danger	87.0 - 89.9	No Limit	0.75	30/30 min	0.75	20/40 min	1.0
Extreme Danger	90.0 +	50/10 min	1.0	15/45 min	1.0	10/50 min	1.0

5.4. Wearing body armor adds 5 degrees Fahrenheit to WBGT.

5.5. Wearing all MOPP overgarments, tyvek suits, etc., adds 10 degrees Fahrenheit to WBGT

5.6. Work/rest cycles are for acclimated personnel. New arrivals (non-acclimated) should use next higher category for the first 8-10 days until adjusted.

CAUTION: Hourly fluid intake should not exceed 1.5 quarts per hour or 10 quarts per day.

6. Symptoms of Heat Stress and Emergency Actions. Heat stress symptoms include one or more of the following: headaches, dizziness, faintness, nausea, vomiting, fever, profuse or decreased sweating, cramps, convulsions, lack of coordination, and unconsciousness.

6.1. Move individual to shaded area and give plenty of water to drink.

6.2. Drench victim with water and fan for additional cooling.

6.3. If patient is unconscious or does not respond to above, contact emergency room or on-scene medical technician for aid.

DAVID M. SNYDER, Colonel, USAF
Commander

Attachment 1

GLOSSARY OF REFERENCES AND SUPPORTING INFORMATION

References

AFPAM 48-151 *Thermal Injury*

Fundamentals of Industrial Hygiene, Chapter 12 (Temperature Extremes)

American Conference of Governmental Industrial Hygienists, Threshold Limit Values for Physical Agents in the Work Environment

Revised Policy on the Role of Sports Drinks in the Prevention of Dehydration and Heat Illness

Attachment 2

HEAT STRESS BRIEFING

A2.1. Purpose. To brief all personnel on factors that affect heat stress and preventive measures on preventing the risks of heat stress. This briefing should be given by first line supervisors to all personnel on a routine basis and prior to all exercises.

A2.2. Factors Affecting Heat Stress.

A2.2.1. Unit Factors:

A2.2.1.1. Fatalistic Attitude - "Some casualties are expected".

A2.2.1.2. Poor Doctrine - That withholding water can make a "hot weather fighter".

A2.2.1.3. Poor Nutrition - Three meals per day are vital to replace salt and mineral loss.

A2.2.1.4. Disregard for Weather - Meteorological conditions must be considered in establishing work/training goals.

A2.2.1.5. No water or poor water supply at work and rest sites.

A2.2.2. Individual Factors:

A2.2.2.1. Any illnesses.

A2.2.2.2. Adequate acclimatization.

A2.2.2.3. Age over 40.

A2.2.2.4. Obesity.

A2.2.2.5. Alcohol consumption.

A2.2.2.6. Lack of sleep/rest.

A2.2.2.7. Lack of meals.

A2.3. Preventive Measures. The following preventive measures are a guide in preventing heat stress.

A2.3.1. Prior To Exercise/Deployment:

A2.3.1.1. Screen out individuals with even minor illnesses or pregnant women.

A2.3.1.2. Be rested - 12 hours rest/8 hours sleep.

A2.3.1.3. No alcohol.

A2.3.2. During Exercise:

A2.3.2.1. Prehydrate - Drink at least 1 quart of water prior to beginning of exercise/work day.

A2.3.2.2. Provide 3 meals per day to ensure salt and mineral replacement.

A2.3.2.3. Provide shade for rest cycles. Personnel should not lie down on hot ground or pavement.

A2.3.2.4. Ensure personnel wearing the MCU-2P mask during simulations and exercises are allowed to remove the mask frequently for water breaks and to allow release of body heat through the head.

A2.3.2.5. Provide cooled and flavored (if possible) water and control hydration as follows:

WBGT_(F)	QUARTS_WATER/HOUR
77.0 – 86.9	0.5 – 1.0
87.0 – 89.9	0.75 – 1.0
90+	1.0

A2.3.2.6. Work/rest cycles should be adjusted dependent upon changes in temperature, humidity, wind speed, and solar radiant heat (cloud cover) to decrease the risks of heat stress during hot weather. During these rest cycles, it is important that, if personnel are wearing chemical gear, they remove it to dissipate body heat.

A2.4. Heat Stress Symptoms . Headaches, dizziness, faintness, nausea, vomiting, fever, profuse or decreased sweating, cramps, convulsion, lack of coordination, and unconsciousness.

A2.5. Emergency Actions.

A2.5.1. Move individual to shaded area.

A2.5.2. Drench victim with water and fan for additional cooling.

A2.5.3. Give victim plenty of water to drink.

A2.5.4. Contact the emergency room or on-scene medical technician for assistance.